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ABSTRACT

The Wechsler Intelligence Scale For Children (WISC) and the Metropolitan Achievement Test (MAT) were administered to seventh graders in a New York City school located in a depressed area with a Negro population approaching 100 percent. Full scale and subtest scores were analyzed. A factor analysis of the WISC, MAT, and the two scales combined was conducted using an oblique rotation. Data from this analysis are presented and compared to those obtained in a 1959 investigation using the original WISC standardized population. The hypotheses that the present sample has a basically different intellectual structure from that of the normative group was not supported. The effects of disadvantage seem to be evident in the pattern of high and low subtest means, in which the lowest means are on two subtests (Information and Vocabulary) which are both highly open to cultural and educational influence, and also the best subtests for predicting the academic performance of the group. (Author/RC)

Factor Analysis of Intellectual Performance in Disadvantaged Negro Adolescents*

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Introduction

The area of differences in intellectual performance particularly across racial and cultural lines, is a topic of long-standing interest. Shuey's survey (1958) cites studies going back to 1913 relating to differences between Whites and Negroes. An aspect of the current civil rights upheaval relates to consistently observed differences in intelligence and achievement test scores between Whites and Negroes seen on a wide variety of individual and group measures. It has been suggested (Reissman, 1962; Eels, *et al.*, 1951) that specific non-middle class groups may do poorly on intelligence tests because (a) the pattern of their abilities and skills is different from those tapped by current measures, and/or (b) the nature of the test items is such as to favor middle-and-upper-class children. This report will examine the first hypothesis.

Cohen's (1959) factor analysis of the Wechsler Intelligence Scale for Children (WISC) was based on the original standardization population at ages 7-6, 10-6 and 13-6. Using an oblique rotation he identified a large general factor and five first-order factors: two "Verbal Comprehension" factors, a "Perceptual Organization" factor, a "Freedom from Distractibility" factor and a "quasi-specific" factor. Baumeister and Bartlett (1962) compared the factor structure of the WISC for normal and retarded children, using the standardization population and 100 subjects, ages 13-14, with Verbal and Performance IQ's below 80. Excluding the subtests of Digit-Span and Mazes, their orthogonal rotation yielded a general factor and two specific factors for the normals and a general factor and three specific factors for the retardates. The factor structure was quite similar between the two groups, suggesting a verbal-performance scale division. They also found what they called a "Trace" factor which showed some resemblance to Cohen's "Freedom from Distractibility" factor but only in the retarded group.

* The data reported here were collected during Cooperative Research Project No. 935 and represent a further analysis of the findings reported in: Downing, Gertrude L., Edgar, Robert W., Harris, Albert J., and Storen, Helen. The Preparation of Teachers for Schools in Culturally Deprived Neighborhoods (The BRIDGE Project). Flushing, New York: Queens College of The City University of New York, 1965. The research project was supported by the Cooperative Research Program of the Office of Education, U. S. Department of Health, Education and Welfare. Additional support was provided by the Board of Education of the City of New York, the Board of Higher Education of the City of New York, the New York Foundation, New York Fund for Children, Taconic Foundation, Nathan Hofheimer Foundation, and New York Times Foundation. The Public Education Association acted as sponsor. The present writers are solely responsible for this report. The individual tests were administered by Robert J. Lovinger and Norman B. Reiss.

Another study investigating the clinical sub-group of epilepsy (Dennerll, Broeder, Sokolov, 1964) applied an oblique rotation (Oblimin with biquartimin criterion) and yielded a factor structure similar to Cohen's (1959) except that one verbal factor was found instead of two. Cropley (1964) did not use clinical sub-groups but investigated the differences in intelligence between high and low socio-economic groups. Orthogonal (Varimax) rotations yielded essentially a verbal, a perceptual and a socio-economic factor and a fourth factor difficult to interpret for the group at age 10. At age 12, three factors were found that were fairly similar to those found with the group at age 10. While there was a significant difference in mean Verbal and Full Scale IQ ($p < .01$) between socio-economic groups in favor of the high group, the results did not support the notion of differences in patterning of intellectual abilities related to socio-economic status. Thus, while differences between group means have been shown in the studies cited (Baumeister and Bartlett, 1962; Cropley, 1964; Dennerll, Broeder and Sokolov, 1964), the major finding has been quite general agreement as to the factor structure of WISC in spite of different factor analytic techniques and sample differences.

The present report compares previous findings regarding the factor structure of the WISC with results derived from a group of disadvantaged young Negro adolescents. The major question is: Is the pattern of abilities as disclosed by factor analysis similar to, or different from, the pattern previously found in other populations, and particularly in the normative population?

Method

Subjects. In the Fall and Winter of 1961 the entire entering seventh grade class in a New York City junior high school (excluding the CRMD class²) was tested with the WISC (excluding the Mazes subtest) and with the Metropolitan Achievement Test (MAT), Intermediate Battery, Complete, Form A. Complete data were acquired for 196 subjects. The junior high school was located in a lower-class area of Queens, New York, and more than 90 per cent of the sample were Negro. Mean age of the sample was 12 years, 10 months, with a range from 11-6 to 16-2. The sample included 90 boys and 106 girls.

Procedure. The matrix of intercorrelations for the WISC was factored by the principal components method and then rotated obliquely (Oblimax). An IBM 1620, Model II, computer was employed. A similar analysis was made of the subtests of the Metropolitan. The separate matrices for the WISC and the MAT were then combined, including the intercorrelations between the subtests of the two batteries, and the combined matrix was analyzed as above.

Results

Table 1 shows the mean subtest and IQ scores on the WISC. The WISC subtest scores are the standard scores (age-corrected) derived from the manual. Clearly this group of entering seventh graders was well below the WISC normative population in Verbal, Performance, and Full Scale IQ's. The mean Performance IQ was not significantly higher than the mean Verbal IQ.

² Children with Retarded Mental Development.

Table 1
Results of the Wechsler Intelligence Scale for Children
for Total Seventh Grade Population

W I S C Results	Mean	S. D.	Range
Verbal IQ	89.62	12.02	61-116
Performance IQ	90.43	12.76	50-125
Full Scale IQ	89.01	13.90	67-115
Subtests (standard scores)			
1. Information	7.54	2.27	
2. Comprehension	9.15	2.65	
3. Arithmetic A A	8.47	2.27	
4. Similarities	8.10	2.55	
5. Vocabulary	7.51	2.69	
6. Digit span	9.21	2.56	
7. Picture completion	9.23	2.74	
8. Picture arrangement	9.11	2.49	
9. Block design	8.14	2.59	
10. Object assembly	7.74	2.53	
11. Coding	8.93	2.86	

The subtest means are also shown in Table 1. The group was lowest in Information and Vocabulary, probably the two tests which are most related to cultural stimulation and educational opportunity. They did comparatively well on Comprehension, Digit Span, Picture Completion, and Picture Arrangement, showing on the average, normal understanding of practical life situations presented verbally or pictorially and adequate rote memory. They did less well on Similarities, Block Design, and Object Assembly, showing difficulty in handling abstract material, whether verbal or non-verbal. Arithmetic and Coding were of medium difficulty for the group. Most of the differences between higher and lower subtest scores were significant at the .01 level. The pattern of higher and lower subtests shows a group that has a limited range of information and vocabulary and is more competent in dealing with specific practical situations than in dealing with abstract material.

The MAT subtest means are shown in Table 2. The mean for the battery as a whole is two years below the pupils' grade placement at the time of testing. The highest subtests were Spelling and Arithmetic Computation. The lowest subtests were Social Studies Study Skills, Reading, and Word Knowledge.

Table 2

Mean Grade Scores on The Metropolitan Achievement Test
for Beginning Seventh Grade

T E S T	Mean Grade Score
1. Word Knowledge	4.8
2. Reading	4.8
3. Spelling	5.6
4. Language	5.0
5. Language Study Skills	4.8
6. Arithmetic Computation	5.6
7. Arithmetic Problem-Solving and Concepts	5.3
8. Social Studies Information	4.8
9. Social Studies Study Skills	4.7
10. Science	4.9
Median Grade Score	5.1

The intercorrelations among the subtests of the WISC and the MAT are shown in Table 3. Wechsler (1949) reports tables of intercorrelations among the subtests of the WISC at ages 7-6, 10-6, and 13-6. The mean C.A. of the present sample was 12-10, so the nearest age group is Wechsler's 13-6 age group. Comparison of the correlations in Table 3 with those of Wechsler's 13-6 age group indicates that the r 's in Table 3 form approximately the same pattern as in Wechsler's population, although they are lower in all but three instances.

Table 4 shows the results of oblique rotation of the WISC factor matrix and the intercorrelations among the factors. Loadings below .20 are not considered significant. Factor I, with substantial loadings on the first five subtests of the WISC, appears to be a verbal factor. Factor II, with significant loadings on Picture Completion, Picture Arrangement, Block Design, and Object Assembly, can be identified as a Perceptual Organization factor. The third factor, with loadings on Arithmetic, Digit Span, and Coding, is similar to Cohen's (1959) Freedom from Distractibility factor, though as will be seen subsequently, this interpretation may require modification.

The intercorrelations of the MAT subtests, shown in Table 3, range from moderate to quite high; the median r is .66. Factoring this matrix shows a "general achievement" factor which accounts for over 90 per cent of the common variance. Oblique rotation also reveals three first order factors, as shown in Table 5. Factor A, with highest loadings in Reading, Science and Social Studies Information, seems to be either a Reading Skill factor or a Verbal Comprehension factor. Factor B seems specific to the two arithmetic tests.

Table 3
Intercorrelations Among WISC and MAT Subtests¹

Subtests	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1. Information		54	59	63	70	29	21	28	29	21	21	66	68	50	55	62	61	66	60	53	63
2. Comprehension			40	47	57	13	24	32	31	24	16	40	46	17	32	30	32	43	38	35	38
3. Arithmetic				47	49	32	11	27	29	08	22	50	54	40	48	48	66	73	47	47	47
4. Similarities					60	27	16	26	23	14	18	46	55	32	44	40	48	53	49	45	45
5. Vocabulary						29	26	34	39	28	18	62	64	42	47	53	48	58	55	49	61
6. Digit Span							09	13	18	09	13	30	35	26	32	33	31	37	26	23	33
7. Picture Completion								33	44	53	07	10	16	01	04	02	07	07	03	13	15
8. Picture Arrangement									27	37	21	25	35	10	26	33	26	30	32	32	37
9. Block Design										54	23	26	30	14	27	23	28	33	17	32	31
10. Object Assembly											21	13	19	-02	09	09	11	12	03	15	17
11. Coding												24	26	25	33	29	35	32	27	27	22
12. Word Knowledge													84	77	70	69	66	74	72	59	81
13. Reading														65	68	72	64	74	77	61	83
14. Spelling															69	57	60	62	63	46	62
15. Language																66	72	73	61	53	64
16. Language Study Skills																	65	70	67	51	68
17. Arithmetic Computation																		85	60	50	58
18. Arith. Problem-Solving & Concepts																		69	62	68	
19. Social Studies Information																			57	76	
20. Social Studies Study Skills																					59
21. Science																					

¹Decimal points omitted

N = 196 r = .14, p = .05; r = .18, p = .01

Table 4

Oblique Rotated Factor Matrix of WISC Subtests

Sub test	F a c t o r s			Communality
	I	II	III	
1. Information	.474	.060	.029	.689
2. Comprehension	.448	.124	.121	.456
3. Arithmetic	.199	.137	.253	.483
4. Similarities	.428	.086	.016	.527
5. Vocabulary	.482	.080	.039	.668
6. Digit Span	.005	.074	.257	.184
7. Picture Completion	.064	.584	.073	.424
8. Picture Arrangement	.106	.311	.045	.266
9. Block Design	.017	.488	.141	.468
10. Object Assembly	.042	.664	.027	.552
11. Coding	.085	.089	.250	.149

Intercorrelations Among Factors

	I	II	III
I	1.000	.083	.770
II	.083	1.000	.229
III	.770	.229	1.000

Table 5

Oblique Rotated Factor Matrix of Metropolitan Subtests

Sub test	F a c t o r s			Communality
	A	B	C	
1. Word Knowledge	.187	.063	.238	.853
2. Reading	.360	.054	.024	.836
3. Spelling	.034	.017	.362	.676
4. Language	.029	.244	.158	.688
5. Language Study Skills	.187	.139	.001	.634
6. Arithmetic Computation	.110	.481	.025	.792
7. Arithmetic Prob.- Solv.	.059	.400	.063	.854
8. Soc. Studies Information	.326	.022	.003	.703
9. Soc. St. Study Skills	.252	.081	.077	.464
10. Science	.407	.114	.009	.796

Intercorrelations Among Factors

	A	B	C
A	1.000	.518	.588
B	.518	1.000	.289
C	.588	.289	1.000

Factor C, with highest loadings on Word Knowledge and Spelling, seems to be a Vocabulary or Word Recognition factor. The communalities are high and the intercorrelations between Factor A and Factors B and C are substantial.

As may be seen in Table 3, the intercorrelations between WISC subtests and MAT subtests are generally moderate to high. The two exceptions are Picture Completion and Object Assembly, which correlate about zero with subtests of the MAT. The correlations for the other subtests of the Performance Scale with the MAT are mainly low, but are significant for a sample of this size.

When the intercorrelations between the two test batteries are factored, the common variance accounts for 72 per cent of the total variance. Oblique rotation (see Table 6) distinguishes four factors. Factor I is concentrated in four WISC subtests and seems to be the same Perceptual Organization factor found in the WISC analysis. Factor II is concentrated in the five verbal subtests of the WISC (excluding Digit Span); this seems to be a Verbal Comprehension factor. Factors III and IV are found mainly in the MAT. Factor III has its heaviest loadings in Science, Word Knowledge, Reading, Spelling and Social Studies Information, and seems to be an Academic Learning factor. Factor IV has its heaviest loadings in the three arithmetic subtests (two in MAT, one in WISC) and seems to be specific to mathematical ability. The intercorrelations show a high relationship between Factors III and IV, both of which are centered in the subtests of the MAT. The correlation between Factors II and III is only .395; they seem to be tapping rather different aspects of verbal comprehension. While there is a substantial correlation between WISC and MAT, each is measuring certain specific factors which the other does not measure. The substantial communality between WISC and MAT may be identifiable as general intelligence or aptitude for school learning.

Discussion

The major question in this paper is: Is the pattern of abilities in this population similar to, or different from, that of other populations? This question may be approached from two points of view.

The first is to interpret the differences among subtests. As may be seen in Table 1, the mean subtest scores on the WISC are depressed below those of the normative group, but the depression is not uniform. Statistically significant differences are observed among subtests, which may reflect: (a) specific school and social experiences that lead to a relative depression of school-rated and perceptually-related subtests, and a relative elevation of subtests with a social comprehension content; or (b) an organization of abilities inherently different from that of the standardization population; or (c) capitalization upon chance factors. Since the variations among the WISC subtests correspond with what is known about the typical background and functioning of this type of pupil (Bloom, et al, 1965), it seems most reasonable to view the pattern of functioning as reflecting specific past experiences common to this group as a whole. On similar grounds, viewing these findings as supporting an inherently different organization of abilities seems unparsimonious, and the possibility of an unusual combination of chance factors seems quite unlikely.

The second and major approach to the question of patterning of intellectual functioning is based on comparison of the factor analysis reported here with those

Table 6

Oblique Rotation of Factor Matrix of WISC and
Metropolitan Subtests Combined

S u b t e s t	F a c t o r s				Communality
	I	II	III	IV	
1. Information	.005	.395	.075	.081	.711
2. Comprehension	.159	.461	.053	.015	.476
3. Arithmetic	.007	.259	.200	.433	.607
4. Similarities	.026	.454	.047	.114	.531
5. Vocabulary	.138	.409	.106	.031	.675
6. Digit Span	.007	.043	.022	.135	.156
7. Picture Completion	.614	.071	.040	.080	.433
8. Picture Arrangement	.639	.078	.052	.018	.296
9. Block Design	.550	.003	.072	.105	.431
10. Object Assembly	.714	.021	.047	.035	.561
11. Coding	.154	.133	.005	.199	.197
12. Word Knowledge	.074	.014	.474	.091	.837
13. Reading	.003	.093	.404	.081	.838
14. Spelling	.188	.202	.418	.029	.663
15. Language	.079	.102	.218	.206	.676
16. Language St. Skills	.083	.019	.284	.088	.642
17. Arithmetic Computation	.101	.012	.046	.473	.797
18. Arithmetic Prob.-Solv.	.110	.089	.005	.404	.879
19. Soc. Studies Information	.145	.076	.397	.063	.714
20. Soc. Studies St. Skills	.050	.088	.171	.074	.473
21. Science	.035	.014	.480	.158	.792

Intercorrelations Among Factors

	I	II	III	IV
I	1.000	.167	.031	.154
II	.167	1.000	.395	.017
III	.031	.395	1.000	.795
IV	.155	.017	.795	1.000

reported on other populations. Cohen (1959) reported factor analyses of the WISC at ages 7-6, 10-6, and 13-6, using the original standardization sample. He identified five factors (also using oblique rotations) and considered loadings of .20 and above to be meaningful. For the oldest age group, he found two Verbal Comprehension Factors. The first - Factor A, containing the Information, Comprehension, Similarities and Vocabulary subtests - had loadings ranging from .26 to .47 and appeared to be related to formal learning. The second factor - Factor D, containing the Comprehension, Similarities and Picture Completion subtests - had loadings ranging from .20 to .27 and seemed to Cohen to apply to use of verbal skills in new situations. The two factors were closely related at the lower age levels. (r 's of .73 and .84) though less so at the higher age level considered here ($r = .43$). Cohen's two verbal factors are represented as Factor I in the present sample. Whether this is a real difference, or an artifact of the factor analytic procedure, cannot be answered here.

Cohen's factor B, which he names Perceptual Organization, contained Picture Completion, Block Design, and Object Assembly with loadings of .46 or higher. WISC Factor II in the present study contains these three subtests but also includes Picture Arrangement, suggesting that this is essentially the same factor. Cohen also found a Factor C, similar to Factor III here, which had significant loadings in Arithmetic, Digit Span and Mazes. We did not give Mazes, but Factor III here, which includes Arithmetic, Digit Span, and Coding, seems much the same as his Factor C. Interpreting Factor C as an attention factor, Cohen labeled it Freedom from Distractibility. There may be some clinical justification for this nomenclature, but the combined factor analysis of the WISC and the MAT suggests that Factor III may relate more to numerical ability than to attention. Finally, Cohen's fifth factor, Factor E, which showed loadings on Picture Arrangement and Coding, he called a quasi-specific factor and declined to interpret. Our WISC results did not warrant going beyond three factors.

Since Cohen's analysis was based on the original WISC normative population and utilized a very similar factor analysis procedure to the one in the present study, it seems highly significant that very similar factors are found in his study and ours. The general intellectual pattern does not differ essentially in the two populations. The main difference is a lower relationship between verbal and non-verbal abilities in the present study.

Baumeister and Bartlett's (1962) comparison of normals (WISC standardization population, age 13-6) and retardates used 10 subtests (excluding Digit Span and Mazes) and an orthogonal rotation. For the normals, this yielded a General factor, a Verbal factor which loaded on Information, Comprehension, Arithmetic, Similarities and Vocabulary, and a Performance factor which loaded on Picture Completion, Picture Arrangement, Block Design and Object Assembly. The major difference between those findings and present results is the absence of a separate attention or number factor in the Baumeister analysis. This may be due to the use of an orthogonal rotation. Baumeister and Bartlett did find a third factor with the retarded group which they called a "Trace" factor and which loaded on Arithmetic, Coding and Picture Arrangement. This third factor, which shares two subtests with our Factor III, may have been somewhat different from our Factor III because they had not used the Digit Span subtest, which is included in our Factor III.

The sample of epileptics studied by Dennerll, et al, (1964) yielded a generally similar picture. Using an oblimin solution with data taken from a younger

group (mean age = 10.3, σ = 2.9) with a wider range, they rotated both four and five factors. The four-factor rotation appeared more meaningful. The first factor had loadings above .60 on Information, Comprehension, Similarities and Vocabulary. Much lower loadings (in the .20's) were found for Arithmetic, Picture Completion and Picture Arrangement. The second factor had loadings above .45 on Block Design and Object Assembly, while Picture Completion and Picture Arrangement loaded at .25. These latter two subtests also had loadings of about .25 on the fourth factor. The third factor had significant loadings for Arithmetic, Digit Span and Coding and was similar to our Factor III. The rather complex structure seen in the Performance Scale, where Picture Completion and Picture Arrangement had loadings on three of Dennerll's four factors, is puzzling. This may have stemmed from the wide age range sampled since there may be changes in factor structure with increasing age.

Cropley (1964) examined a group of normal subjects for socio-economic status in relation to WISC functioning at ages 10 and 12. At age 12 three factors were extracted with an orthogonal (Varimax) technique. The first had loadings above .50 for Information, Comprehension, Arithmetic, Similarities, Vocabulary, Block Design and Object Assembly. Picture Completion had a loading above .40. The second factor was a socio-economic factor with low loadings (below .37) for the Verbal scale subtests. The third factor showed loadings above .68 for Picture Completion and Picture Arrangement and above .23 for Block Design and Object Assembly. There seems to be a resemblance of his first factor to our Factor I, and of his third factor to our Factor II, but his loadings are higher than ours, and his factors seem more inclusive. The inclusion of three measures of socio-economic status in his matrix may account for the differences.

We have been unable to find a factor analysis study combining the WISC and MAT for a normative population of young adolescents, with which our factor analysis of the WISC-MAT correlation can be compared. The high common variance is subject to alternative explanations. Another look at Table 3 reveals that for eight of the ten MAT subtests, the two WISC subtests with the highest r 's are Information and Vocabulary. These are also the two subtests on which the present population did least well (Table 1); and the two subtests as well which are commonly thought to be most strongly open to influence by cultural and educational opportunities. It would seem reasonable to conclude, therefore, that the MAT and the WISC are both somewhat depressed by educational and cultural disadvantage in the present population, and that the WISC subtests in which this influence is most strongly evident are the ones which correlate most highly with achievement.

Summary

In a series of studies concerned with the factorial structure of the WISC with a variety of groups, the general trend indicates that the pattern of intellectual ability is relatively invariant. A Verbal factor comprising Information, Comprehension, Similarities, and Vocabulary is found, as is a Perceptual factor which contains Block Design, Object Assembly, Picture Completion and often Picture Arrangement. Somewhat less consistently but usually present is a third factor relating to numerical ability, which encompasses Arithmetic and Digit Span (when administered) and often Coding.

There is little support for the hypothesis that the present sample of disadvantaged Negro adolescents has a basically different intellectual structure from

that of the normative group or of other specific subgroups. The essential similarity between the factor structure on the WISC for this population and the results of other factor analytic studies with the WISC is clear. At the same time, the effects of cultural and educational disadvantage seem to be evident in the pattern of high and low subtest means, in which their lowest means are on two subtests (Information and Vocabulary) which are both highly open to cultural and educational influence, and also the best subtests for predicting the academic performance of the group.

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